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Gull Lake Study- Volume 1 - Summary Report. 1
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GULL LAKE STUDY

VOLUME I

PREPARED FOR

GULL LAKE CO-ORDINATING
COMMITTEE

BY

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GULL LAKE STUDY

PREPARED FOR

GULL LAKE CO-ORDINATING COMMITTEE

SUBMITTED BY:
R.E. BAILEY
DIRECTOR
WATER RESOURCES DIVISION
DEPARTMENT OF AGRICULTURE

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Project Leader

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Interdepartmental Co-ordinating
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SYNOPSIS

The problem of steadily declining water levels at Gull Lake during the past twenty years has been the subject of various studies. Several solutions to this problem have been suggested which vary a great deal both in nature and in cost.

This report compares in detail the two most feasible of eighteen selected alternatives proposed for raising the lake level. It also includes proposals for maintaining the lake level at the present elevation.

The estimated cost of the recommended alternative to raise the lake level is approximately $600,000, while the estimated cost for maintaining the present lake level is approximately $360,000.

GENERAL PROJECT INFORMATION

Introduction

Gull Lake, located in townships 40, 41 and 42, ranges, 28 west of the 4th and 1 west of the 5th has long been considered as one of Central Alberta's recreation centers. However, a record of steadily declining lake levels has caused growing concern among both recreationists and the general public. The lake has experienced an average annual decline of 0.2 feet over a forty-four year period. Plate No. 2 illustrates the changing lake levels since 1924. This average decline represents an annual loss of 4200 acre-feet of water from Gull Lake.

Causes for the Decline

The decline in the Gull Lake water level is due to:

1. A decreasing precipitation - evaporation ratio. Long term precipitation averages only 18.3 inches per year, compared to an increasing annual average evaporation loss, which is at present 26.5 inches. Similar situations have been observed on Lake Miquelon, Pigeon Lake and Cooking Lake. This seems to indicate a general climatic trend.

2. Other contributing factors may be:-

   a) Reduction of inflow from groundwater. Since there is no indication of stagnation in the lake and no recorded discharge of water through the outlet, it is possible that the lake is supplied by groundwater. A lower inflow from groundwater could result in declining lake levels.

   b) Changes in land use and drainage patterns. A gradual transition from the original vegetation cover to inten-

sively used farm land along with disturbance of natural drainage patterns by roads, ditches, wells or dugouts may have changed surface runoff and groundwater levels.

Physiography

Gull Lake lies within the Parkland Region of Central Alberta, a transition zone between the prairie to the east, and the forested foothills to the west. The lake is a remnant of a larger body of water which developed during the last stages of the most recent glacial period. The upland areas surrounding Gull Lake were also modified during the glaciation, and the surface features observed are largely of glacial origin as well.

The area of immediate concern consists of three watersheds, the Gull Lake drainage basin, the Lloyd Creek drainage basin, and the Blindman River drainage basin. Although for the purposes of the study, the Lloyd Creek watershed is considered to be a discrete unit, it is of course also a tributary of the Blindman River. The physiography of these watersheds is quite varied, ranging from level lacustrine plains to hummocky dead ice moraines.

The southern portions of the Blindman River and Gull Lake drainage basins are characterized by level to gently rolling ground moraine and level lacustrine plains. The lacustrine plain extending up the Blindman River valley widens in the vicinity of the Town of Rimbey, accounting in part for the more extensive agriculture practiced in the vicinity. North and east of Gull Lake the land becomes rougher, consisting of strongly rolling ground moraine and hummocky dead ice moraine. The hummocky dead ice moraine is a particularly dominant landform, which while only some thirteen miles long by two miles wide, has restricted agricultural development. The northern portion of the Lloyd Creek and Blindman drainage basins is largely rolling to strongly rolling ground moraine.

Recreation

Gull Lake, centrally located between the major metropolitan centers of Edmonton and Calgary and within 25 miles of Red Deer, the Province's fourth largest city, lies within a two and one-half hour driving distance of some eighty percent of Alberta's population. Highway No. 12, which skirts the southern lake shore, provides good access for motor vehicle traffic. With its central location and good access, Gull Lake attracts summer recreationists seeking water-based and related recreation activities. Three other lakes, Sylvan, Pigeon and Buffalo, located in the same general region offer competition to Gull Lake in attracting recreationists. However, there are indications that the existence of these four recreation-oriented lakes in the same general vicinity act as complimentary alternatives to recreationists.

Gull Lake, with some thirty-two miles of shoreline, much of which is still undeveloped, attracts those seeking a quiet family outing. The development which has taken place is largely concentrated on the southern portion of the lake, with smaller developments scattered around other sections of the lake shore.

Public access to Gull Lake is provided by Aspen Beach Provincial Park located on the south-west end of the lake; by a County of Ponoka Recreation Center on the north end; by a Lacombe Fish and Game Association Recreation shelter on the east side; and a Department of Highways Campsite located on the west side of the lake. Of these, Aspen Beach Provincial Park is the largest and most heavily utilized. Accommodation is provided for both day use and overnight camping. As a result of the fine sandy beach conditions and the facilities provided, Aspen Beach Provincial Park is one of the most intensively utilized Provincial parks in Alberta.

In addition to the public accommodations provided, private sub-

divisions for cottage use have also been developed. At present there are ten cottage subdivisions on Gull Lake, with a total of 263 cottages on lake frontage lots, and 108 cottages on non-frontage lots. As well, there are five church camps which provide facilities for youth activities.

Historical Background

During the past five decades, declining water levels on Gull Lake have resulted in receding shorelines. A visitor to Gull Lake today, viewing the wide expanses of sandy beach, the shallow water conditions, and finding no obvious inlet to or outlet from the lake, would be surprised to learn that Gull Lake once served as a hydro reservoir. This, nevertheless, is the case. At the turn of the century, Gull Lake stood at an elevation high enough to discharge through its spillway, located on the south-west side of the lake. The crest of this natural spillway is at an elevation of 2963 feet above sea level. In 1969, lake levels reached a low of 2949 feet, a decrease of some fourteen feet.

In 1908, after being licensed under the Dominion of Canada Irrigation Act, the Blindman River Electric Power Company, Ltd. constructed a concrete dam at the crest of the Gull Lake spillway. The company was authorized to store water 18 inches above the normal level of the lake, and to draw the water level down 18 inches below the normal elevation. This would have resulted in a three foot fluctuation of Gull Lake's surface elevation. The purpose of storage on the lake was to provide additional flows in the Blindman River, for electric power generation.

The role of Gull Lake as a hydro reservoir was, however, quite short-lived. In 1910, persons unknown but obviously unfriendly to water

storage on the lake, dynamited the control structure. Removal of the dam permitted the water level on Gull Lake to drop 1.5 feet below the "normal" lake elevation. By 1921, the lake level stood at an elevation some three feet lower than the high water mark.

The first formal complaint on record concerning low lake levels was received by the Commissioner of Irrigation at Calgary in October, 1921. The complainant, a cottage owner at Aspen Beach, reported that the lake level had declined two feet subsequent to the dynamiting of the dam, and requested that some action to restore the lake level be taken. During the same month, the Village of Gull Lake constructed a new earth and concrete dam in the Gull Lake outlet. This dam remains in place today, located approximately one mile from the present shoreline.

Recent Developments

As water levels continued to decline on Gull Lake, concern over the situation increased among local residents, cottage owners, and visitors. This concern was evidenced by the formation of groups of concerned citizens. One such group was the Gull Lake Conservation Committee. Another organization which has been active in directing attention to the problem is the Central Alberta Chamber of Commerce.

In 1967, the Water Resources Division, Alberta Department of Agriculture, undertook a series of preliminary studies of means of alleviating the problem at Gull Lake. Preliminary investigations indicated that the possibility of stabilizing the lake level by pumping from groundwater was low. However, two surface water sources, the Blindman River and Lloyd Creek, appeared to have some potential. A possible storage and diversion scheme on Lloyd Creek was outlined. Further studies, however, were recommended.

Realizing the implications for the area if Gull Lake was lost as a recreation resource, the Red Deer Regional Planning Commission in 1968 retained Dr. A. H. Laycock, of the University of Alberta as a technical consultant. Dr. Laycock was commissioned to prepare a report on the continuing decline of water levels on Gull Lake. A report, "The Water Balance of the Gull Lake Basin", was submitted by Dr. Laycock the same year. Dr. Laycock concluded that a diversion scheme from Lloyd Creek plus increased local drainage to the lake would result in achieving a water balance.

As a result of these reports the Red Deer Regional Planning Commission, in conjunction with the Battle River Regional Planning Commission, submitted a brief to the Provincial ARDA Advisory Committee. The brief requested that consideration be given to granting assistance for development of a resource conservation project. As stated in the brief, the objective of the project would be to "stabilize water levels in Gull Lake by watershed management in the Gull Lake and Upper Lloyd Creek Basin involving improved land use and productivity by means of drainage, phreatophyte control and diversion". Although the brief received consideration, it was not acted upon.

Present Study

In March of 1969, the Gull Lake Coordinating Committee, under the auspices of the Inter-departmental Coordinating Committee on Watershed Development, formed a Gull Lake Study Task Force. The Task Force, formed by personnel from various Government agencies, was directed to investigate several alternative proposals for stabilizing Gull Lake. Although a broader regional study involving the Central Alberta lakes district could

have been undertaken, it was the decision of the Gull Lake Coordinating Committee that the Task Force confine its studies to the problem of Gull Lake only.

The alternative proposals for stabilizing water levels on Gull Lake were to be investigated on the basis of engineering, land use, and economic feasibility studies. The most feasible alternative was to be recommended. This recommended project would then be presented to a committee of concerned citizens for consideration.

Methodology

To aid in the organization and completion of required activities, the Task Force decided to implement network diagramming. Network diagramming basically is a tool which develops efficient coordinating and scheduling of the various phases of investigation involved in a study. The Gull Lake Study involved many interrelated problems and factors which had to be considered fully. Therefore, it was felt that without a network diagram, preparation of the report would be very difficult, if not impossible.

Scope of the Study

In order to prepare the report the following studies were undertaken:

1. Office and field reconnaissance studies.
2. Ground control and mapping.
3. Hydrology.
4. Groundwater studies.
5. Geographical studies.
6. Economic studies.
7. Hydraulics and design.
8. Cost estimates.
9. Benefit-cost analysis.

Plate No. 11 shows the network diagram of the activities involved.

SELECTION OF ALTERNATIVES

Summary of Proposals

As a result of the various studies made of the problem, the following alternatives were proposed. (See Plate No. 3)

TABLE No. 1 - SUMMARY OF PROPOSED ALTERNATIVES

	No.	ALTERNATIVE	TOTAL LENGTH OF ROUTE IN FT.	PRELIMINARY COST IN $	NOTES
DIVERSION PROPOSALS	1.	Blindman River I	15,000	600,480	Selected for further study
	2.	Blindman River II	32,400	798,000	
	3.	Blindman River III	35,600	807,900	
	4.	Blindman River IV	18,300	720,400	
	5.	Battle Lake	131,000	3,001,000	
	6.	Medicine River	114,000	3,061,400	
	7.	Red Deer River	76,000	1,681,000	
	8.	Battle River	86,000	2,596,600	
	9.	North Saskatchewan River	299,200	7,287,000	
	10.	Clearwater River	328,600	7,892,000	
	11.	Lloyd Creek-Pumping Scheme	48,000	650,000	Selected for further study
	12.	Lloyd Creek-Gravity Scheme	45,000	1,781,000	

Continuation of Table No. 1

	No.	ALTERNATIVE	TOTAL LENGTH OF ROUTE IN FT.	PRELIMINARY COST IN $	NOTES
WATERSHED MANAGEMENT PROPOSALS	13.	Wells Groundwater	22 wells	600,000	Rejected, Ref. App.A-5
	14.	Removal of Phreatophytes		Not evaluated	Rejected,
	15.	Monomocecular Films	....	54,700/yr.	Rejected,
	16.	Drainage System	....	Effective if combined with a diversion scheme	
	17.	Precipitation increase	....	Beyond existing technology	
	18.	Watershed Management	....	Not evaluated,	Low effect, Ref.*

* Dr. A. H. Laycock, The Water Balance of the Gull Lake Basin.

Selected Alternatives for Detailed Study

From the preliminary comparison of the eighteen proposed alternatives, two were selected for detailed study. The results of these studies are attached as appendices. A brief resume of each alternative follows:

1. Diversion from Lloyd Creek

This alternative consists of:

(a) A pumping plant with a maximum output of 30 cubic feet per second.

(b) A pipeline 30 inches in diameter, 1800 feet long.

(c) An unlined main canal, 45,000 feet long.

(d) 20,000 feet of lateral canals to collect and convey surface runoff to the main canal.

(e) Drainage of 10.5 square miles adjacent to the lake.

Hydrology studies indicate that the mean annual supply from a 30 cubic feet per second pumping installation would be 4100 acre-feet. It is assumed that, on average, lateral canals would collect a further 2,000 acre-feet annually and drainage of areas adjacent to the lake would yield an additional 1,000 acre-feet per year. This would provide a total mean annual flow of 7,100 acre-feet into Gull Lake, 42 percent of the flow depending on drainage.

Plate No. 5 shows the amount of water available annually from Lloyd Creek for a pumping capacity of 30 cubic feet per second.

2. Diversion from Blindman River

This alternative consists of:

(a) A pumping plant with a minimum output of 30 cubic feet per second.

(b) A pipeline, 30 inches in diameter, 5,450 feet long.

(c) An unlined canal 4,450 feet long.

(d) An existing channel 7,100 feet long.

(e) Drainage of 10.5 square miles adjacent to the lake.

If a five cubic feet per second riparian flow were maintained in the Blindman River below the pumping plant, the plant could supply Gull Lake with an average of 8,550 acre-feet per year, as shown in Plate No. 6. Drainage of areas adjacent to the lake would supply an additional 1,000 acre-feet per year, a total supply of 9,550 acre-feet. Only 11 percent of this supply would be dependant on drainage.

Plate No. 4 shows the general plan and profiles for the two alternatives.

Each alternative could be constructed without the drainage of 10.5 square miles adjacent to the lake. Table No. 2 compares the Lloyd Creek and Blindman River alternatives with and without the additional drainage.

The graph shown in Plate No. 7 indicates the average length of time that would likely be required by each alternative to raise the lake to 2,953 feet, and Plate No. 8 shows the lake levels which would have existed in Gull Lake had either alternative been implemented in 1961.

TABLE No. 2 - PERTINENT DATA ON THE SELECTED ALTERNATIVES

		DIVERSION SCHEME			
		FROM LLOYD CREEK		FROM BLINDMAN RIVER	
ITEM	UNIT	PUMPING	PUMPING AND SURFACE DRAINAGE	PUMPING	PUMPING WITH ADDITIONAL DRAINAGE
Total length	ft	46,800	46,800	9,900	9,900
Pressure Pipe	ft	1,800	1,800	5,450	5,450
Main canal	ft	45,000	45,000	4,450	4,450
Additional canals	ft	20,000	27,000	-	7,000
Static head	ft	27	27	131	131
Dynamic head	ft	34	34	151	151
Maximum capacity	cfs	30	30	30	30
Annual supply from pumping	ac-ft	4,100	4,100	8,550	8,550
Annual supply from lateral canals	ac-ft	2,000	2,000	-	-
From additional drainage	ac-ft	-	1,000	-	1,000
Total annual supply	ac-ft	6,100	7,100	8,550	9,550
Probable time to raise lake to 2953 (from 2949)	Yrs.	35	23	15	12
Input power to plant	Kw	114	114	506	506
Consumption of power/year	kwh	187,000	187,000	1,750,000	1,750,000
Annual cost of power	$	3,500	3,500	19,300	19,300
Annual supply for stabilization	ac-ft	2,200	1,200	4,200	3,200
Annual cost of power for stabilization	$	1,875	1,020	9,460	7,200

COST ESTIMATES

Plate No. 9 compares the cost estimates of the Lloyd Creek and Blindman River alternatives. Unit costs were obtained from the Saskatchewan-Nelson Basin Board Technical Report # 2 (April 1969) and were adjusted according to current market prices. Since quantities and unit prices have been recently revised, the cost estimates given on Plate 9 do not agree exactly with the originals given in the Appendix A-2.

Plate No. 10 shows the cost of raising and maintaining the lake level, and the total cost versus time.

Land Use

Because the two engineering alternatives chosen for more detailed investigation depend on local surface water sources, an analysis of the land use characteristics of the contributing watersheds is necessary. One very important factor in the final selection of one alternative will be water quality. Present and potential land use and other related cultural practices will have a direct bearing on the quality of water available from Lloyd Creek, and from the Blindman River.

Generally, it can be stated that an inverse relationship exists between water quality and human occupation. That is, water quality declines as agricultural, municipal, and industrial activity increases. The Blindman River watershed is more developed agriculturally than is the Lloyd Creek watershed. Some 65 percent of the area in the Blindman River watershed is cultivated or improved, while some 62 percent of the Lloyd Creek watershed is unimproved. However, landownership patterns within the two watersheds are quite similar, with over 85 percent of all lands being patented. A survey of landowners regarding the use of agricultural chemicals indicates that fertilizers and herbicides are utilized more extensively in the Blindman River watershed than in the Lloyd Creek watershed. There was no reported use of insecticides in either watershed during 1969.

The only sizeable settlement within the area is the Town of Rimbey located in the Blindman River watershed, northwest of Gull Lake. The Town has both a public water and a public sewage system. Sewage treatment is by means of sewage lagoons. The effluent is released during spring runoff into a water course which eventually drains to the Blindman River. The only major industrial plant within the area is a gas plant located in the Lloyd Creek watershed, which discharges industrial effluent into Lloyd Creek.

A comparison of the two engineering alternatives, pumping from the Blindman River, and pumping from Lloyd Creek plus drainage of sloughs contiguous to the diversion canal indicates there are advantages and disadvantages to both proposals. Water quality in the Blindman River will be affected by agricultural land use practices, and by municipal and industrial effluents. Because the stabilization program is a long term project, increased agricultural activity including greater use of agricultural chemicals, growing populations, and increased industrial development during the life of the project would increase the likelihood that water quality would be adversely affected. With the pumping station located on the Blindman River downstream from the above mentioned developments, the only control over water quality would be preventing the introduction of contaminants.

Water quality in Lloyd Creek will be effected by agriculture and industry. Because the watershed is relatively undeveloped for agriculture at present, fewer agricultural chemicals will be introduced. Although the pumping station on Lloyd Creek is located downstream from the gas plant, modifications in project design could be incorporated which would allow the industrial effluent to bypass the diversion point. The Lloyd Creek proposal also includes drainage of sloughs in the moraine north of Gull Lake. Drainage of these sloughs could result in increased agricultural production, although the area has a very low rating for agricultural capability. On the other hand, the area has a high rating for waterfowl capability which could only be reduced by a drainage program.

The major advantage of the Lloyd Creek proposal is the assumed higher quality of water which would be available from this watershed. Water samples taken to date do not show any appreciable difference in water quality

between the Blindman River and Lloyd Creek. Unless more intensive sampling reveals higher water quality in Lloyd Creek, the Blindman River proposal would be preferable, since this proposal would be much less disruptive to the ecology of the area.

LAKE LEVEL STABILIZATION

Requests for a program to stabilize lake levels at Gull Lake have been received from concerned cottage owners, local business organizations and members of the public at large who utilize Gull Lake as a resort area. Problems which have resulted from the declining lake levels include receding shorelines exposing poorer foreshores and backshores, and shallow water conditions, which have contributed to a declining recreational capability. As the shoreline has receded, access to the lake has become a problem, especially for private cottage and boat owners. Shallow water conditions have resulted in hazards to boaters and water skiers, and have contributed to a general decline in the aesthetic quality of the recreation experience at Gull Lake.

If a lake stabilization program is initiated, a suitable level for stabilization must be determined. Studies have been completed to establish such a recommended elevation. Studies undertaken include recreation capability classifications for Gull Lake if lake levels were raised to elevations 2952 feet, 2953 feet, and 2954 feet. As well, beach material samples were collected and analyzed for suitability for beach development; accrued acreages were assessed for livestock carrying capacity to establish the usefulness of beach areas for grazing; and the elevations of existing vegetation lines were established to determine at what elevation vegetation would be flooded. Another important consideration was the elevation of

existing and potential recreation developments, both private and public.

As a result of these studies, the recommended stabilized lake elevation is 2953 feet. This would be a rise of four feet over the lake elevation as of June, 1969. A further recommendation is that control over the Gull Lake outlet be obtained, to insure that lake levels do not rise above elevation 2954 feet.

ECONOMIC FEASIBILITY

This analysis has set as its goal the provision of meaningful economic information for the policy makers who are faced with an investment decision. The information is set within a benefit-cost framework which assumes economic efficiency as the deciding criterion, given an existing set of provincial and municipal policies. The question asked is, "Do the benefits exceed the costs?"

Before setting out the quantitative answers, a review of the major assumptions is required.

1. The number of visits by park users, estimated at 38,000 visits (cars) during the recreation season, May 15 to September 15th, is the difference between the one-way total traffic flow and 90% of the average annual flow of traffic over the same period, as measured by a traffic counter located five miles west of Lacombe on Highway No. 12.
2. The "travel cost" method used to indirectly estimate the demand for recreation at a site, which is still being improved on by the academic world, adequately measures the park user's willingness to pay for the enjoyment of recreation at Gull Lake.
3. The site value of the park can be estimated by determining

a maximum benefit, which results from a unique price and quantity within the demand schedule. This method assumes little substitution of Gull Lake by the park users for some other site.

4. Park costs, above present revenues from camping and trailer units are not included in the benefit-cost framework. As a consequence, present benefits of the park and the lake combined are attributed solely to the project on the basis that unless the water is stabilized they will be lost. If investment, operation and maintenance costs for the park are included within the decision-making framework, benefits from park users attributable to the project would be lowered substantially. Further analysis, would be required to estimate the exact proportions.
5. Cottage benefit estimations are dependent on the assumption that frontage lots at Gull Lake will take on values similar to Sylvan, when the water level has been raised 4 feet. This is likely to be a maximum. It is conceivable that lot values might be lower at Sylvan Lake when Gull Lake's water level is raised as a larger supply of similar lots in the same area would then be available for prospective buyers.
6. The project life of 50 years is a life based on physical rates of deterioration. It is appropriate to ask if projects should be assigned to the next generation for collection of benefits. A shorter economic life would avoid the hazards of new substitutes becoming available which would make recreation at Gull Lake obsolete. A shorter life would reduce the benefits attributable to the project.

7. An 8½% interest rate may be less than that required to raise the funds for financing the project under present economic conditions. Benefits would be reduced more than costs with an increase in the interest rate.

The first seven assumptions tend to discount the quantitative measurement of benefits which has been presented.

8. The demand for recreation at Gull Lake has not been projected into the future. An analysis of the general demand for "on site" recreation at lakes with parks and cottages is beyond the scope of this study. However, if real incomes and populations continue to rise, this increase would weigh heavily in favour of increasing the benefits of water level stabilization at Gull Lake, other things remaining the same.
9. No benefits have been acknowledged for users of the resource who attend church camps or other smaller campsites at the project. These would be added benefits, given water level stabilization.

The summary of benefits and costs is now made in Table No. 3. The project appears favourable at a 5% interest rate for all four proposals. At 8½ only the Blindman River and Lloyd Creek proposals with drainage are favourable.

In addition, regional net indirect benefits have been estimated at $146,651 with a discount rate of 5% and $73,003 with a discount rate of 8½%.

TABLE No. 3

SUMMARY OF THE PRESENT VALUE OF BENEFITS AND COSTS FOR THE GULL LAKE LEVEL STABILIZATION PROJECT

	DISCOUNT RATE	DIRECT PARK BENEFITS	+	DIRECT COTTAGE BENEFITS	=	TOTAL DIRECT BENEFITS	-	PROJECT COSTS	=	NET DIRECT BENEFITS	BENEFIT COST RATIO
BLINDMAN RIVER PUMPING ONLY	5%	$779,000		$640,000		$1,419,000		$845,000		+$574,000	1.68
	8½%	$407,000		$335,000		$ 742,000		$751,000		-$ 9,000	0.98
BLINDMAN RIVER PLUS DRAINAGE	5%	$779,000		$666,000		$1,445,000		$823,000		+$622,000	1.76
	8½%	$407,000		$353,000		$ 760,000		$747,000		+$ 13,000	1.02
LLOYD CREEK PUMPING ONLY	5%	$779,000		$520,000		$1,299,000		$737,000		+$562,000	1.76
	8½%	$407,000		$260,000		$ 667,000		$677,000		-$ 10,000	0.98
LLOYD CREEK PLUS DRAINAGE	5%	$779,000		$584,000		$1,363,000		$737,000		+$626,000	1.85
	8½%	$407,000		$298,000		$ 705,000		$684,000		+$ 21,000	1.03

SUMMARY

1. Diversion from Lloyd Creek by means of pumping, plus considerable additional drainage to the lake, would likely raise Gull Lake to the recommended elevation 2953 feet in approximately twenty-three years. Total investment for this project would be $615,929. Annual charges until the lake level reaches elevation 2953 would be $60,744. Annual charges to maintain this elevation could be $58,264.
2. Diversion from the Blindman River by means of pumping, plus limited additional drainage to the lake, would likely raise Gull Lake to the recommended elevation 2953 feet in approximately twelve years. Total investment for this project is $600,598. Annual charges until the lake level reached elevation 2953 would be $71,988, after which they would be $59,885.
3. More water would be available from the Blindman River, because the drainage area of the Blindman is larger than the drainage area of Lloyd Creek.
4. Present land use practices and population distribution indicate that the water quality should be a higher level in Lloyd Creek as opposed to the Blindman River.
5. Water quality analysis completed to date show no appreciable difference in quality between Lloyd Creek and the Blindman River. However, the quality of water from either source could adversely affect the water quality of Gull Lake by increasing the total dissolved solids in the lake water.
6. The Lloyd Creek diversion plus drainage and the Blindman River diversion plus drainage have the most favourable benefit - cost ratios at 8½ percent interest rate.

Maintaining the Present Lake Level

After appraising the results of the Task Force study, it was decided to supply further information to policy makers, if a decision is taken to maintain Gull Lake at its present elevation (approximately elevation 2949.0 feet). Table No. 4 summarizes the benefits and costs, under the assumption that Gull Lake would be maintained at its present elevation of 2949 feet. Details of engineering costs of maintaining this level are shown on Plate No. 12.

TABLE No. 4

SUMMARY OF THE PRESENT VALUE OF BENEFITS AND COSTS
FOR THE GULL LAKE LEVEL STABILIZATION PROJECT

(NO CHANGE IN LAKE LEVEL ELEVATION)

	DISCOUNT RATE	DIRECT PARK BENEFITS	+	DIRECT COTTAGE BENEFITS	=	TOTAL DIRECT BENEFITS	-	PROJECT COSTS	=	NET DIRECT BENEFITS	B/C Ratio
BLINDMAN RIVER PUMPING ONLY	8½%	$407,000		$165,000		$572,000		$493,000		+$ 79,000	1.16
BLINDMAN RIVER PLUS DRAINAGE	8½%	$407,000		$165,000		$572,000		$445,000		+$127,000	1.28
LLOYD CREEK PUMPING ONLY	8½%	$407,000		$165,000		$572,000		$570,000		+$ 2,000	1.00
LLOYD CREEK PLUS DRAINAGE	8½%	$407,000		$165,000		$572,000		$523,000		+$ 49,000	1.09

RECOMMENDATIONS

The results of all studies undertaken, engineering, land use, and economic, were carefully weighed. If a lake stabilization project is initiated at Gull Lake, implementation of the proposal Blindman River, pumping only, is recommended for the following reasons:

1) Raising Gull Lake to approximately elevation 2953 feet, and stabilizing at this level.

   1. The proposal Blindman River, pumping only, supplies twenty percent more water than does the Lloyd Creek alternative for a lower initial cost.
   2. One hundred percent of the water for the Blindman River alternative would be supplied from stream flow. Forty-two percent of the water supplied by the Lloyd Creek alternative would be from surface drainage, which may be less reliable than stream flow.
   3. The Blindman River alternative would restore the water level to elevation 2953 feet in approximately fifteen years compared to approximately twenty - three years for the Lloyd Creek alternative.
   4. Unless more intensive testing for water quality shows markedly higher water quality in Lloyd Creek, the Blindman River proposal is preferable because drainage of the moraine north of Gull Lake would not be required. Drainage of the moraine lakes would decrease the waterfowl production in the area, and would also lower the recreation potential of this region.

5. The proposal Blindman River, pumping only, would be easier to implement because the diversion route is considerably shorter than that for the Lloyd Creek alternative. Fewer landowners would be affected, reducing right-of-way problems. Also, no drainage of existing surface water bodies which may serve as stock watering ponds would be required.

II Maintaining Gull Lake at approximately its present elevation, 2949 feet.

1. The proposal Blindman River, pumping only, would supply the required volumes of water at a considerably lower initial cost then would the Lloyd Creek alternative.
2. While one hundred percent of the water for the Blindman River alternative would be from stream flow, some seventy-one percent of the water for the Lloyd Creek alternative would be dependant on surface drainage sources.
3. Points four and five of Section I would also apply.

III Other Considerations

1. Decision makers must recognize that diversion of water from either the Blindman River or Lloyd Creek could result in deterioration of water quality in Gull Lake.
2. If a diversion project is implemented, a water quality sampling program on Gull Lake should also be initiated to measure any changes in water quality which may occur.
3. If a recommended elevation for stabilizing the lake level is accepted, control of the Gull Lake outlet should be secured to ensure that water levels do not flood facilities established above the stabilized elevation. Costs of this recommendation

were not assessed in this study.

4. If implementation of a project is recommended, consideration should be given to the negotiation of a cost-sharing agreement to ensure that those groups or individuals receiving benefits from the project share in the costs as well.

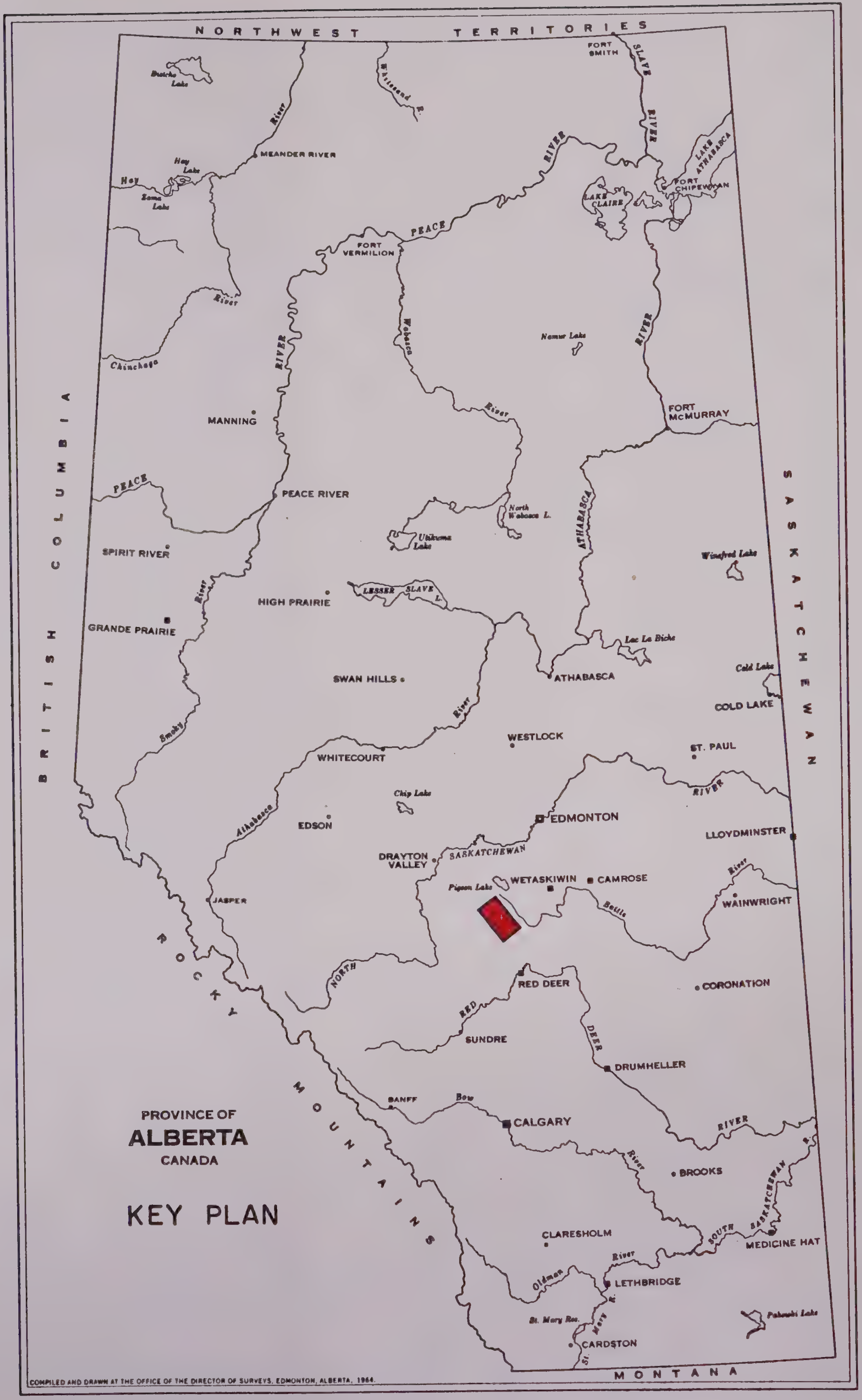
REFERENCES

1. File 255 - Water Resources Division.

2. Gull Lake Level Stabilization, Feburary 1968, Water Resources Division.

3. The Water Balance of the Gull Lake Basin - A system analysis for the period 1921 - 1968 by Dr. A. H. Laycock, 1968.

4. Gull Lake - Water Level Stabilization, A.R.D.A. Submission, by Red Deer Regional Planning Commission.

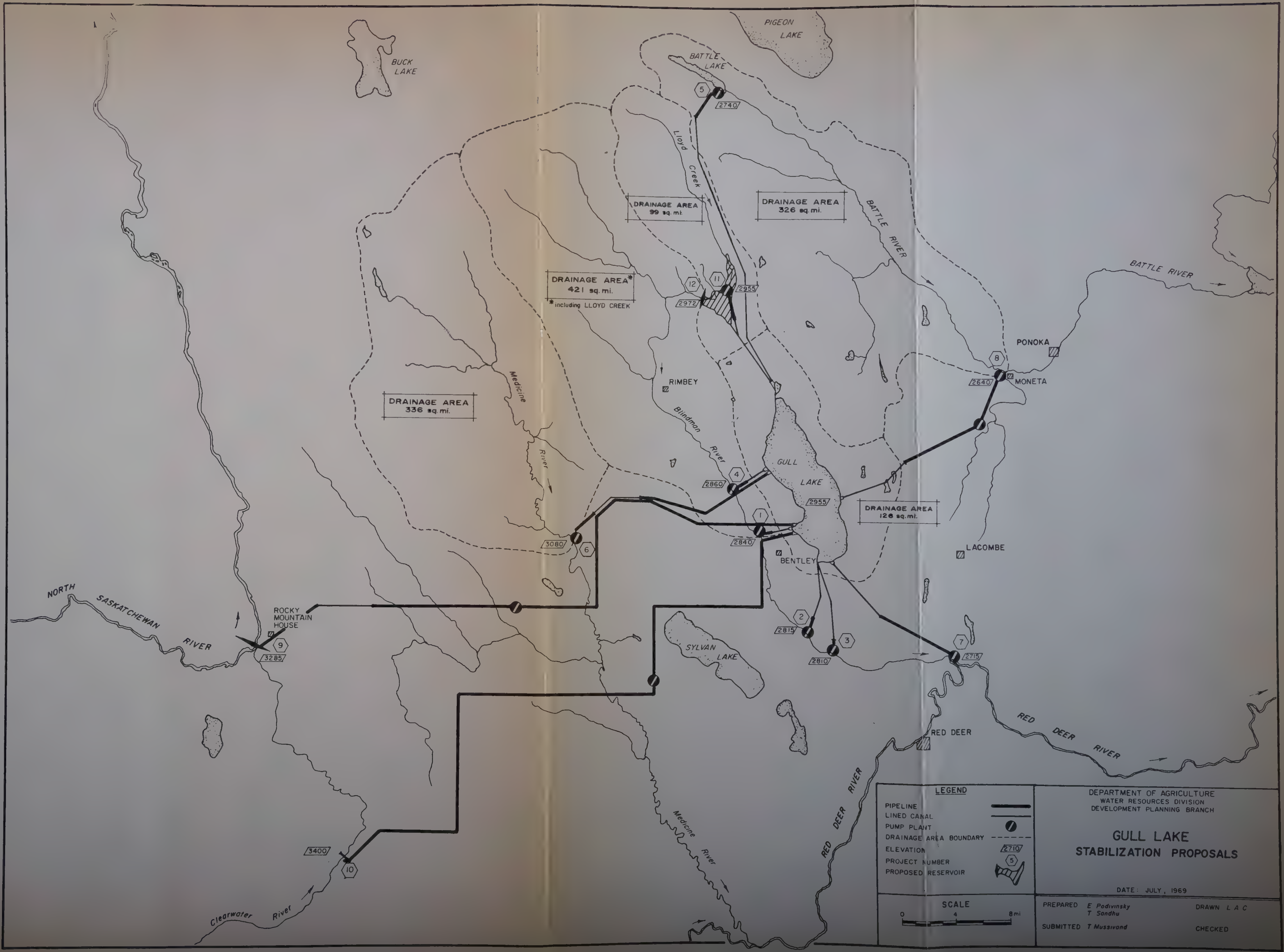


PROVINCE OF
ALBERTA
CANADA

KEY PLAN

COMPILED AND DRAWN AT THE OFFICE OF THE DIRECTOR OF SURVEYS, EDMONTON, ALBERTA, 1964.

PLATE No. I



DEPARTMENT OF AGRICULTURE
WATER RESOURCES DIVISION
DEVELOPMENT PLANNING BRANCH

GULL LAKE
STABILIZATION PROPOSALS

DATE: JULY, 1969

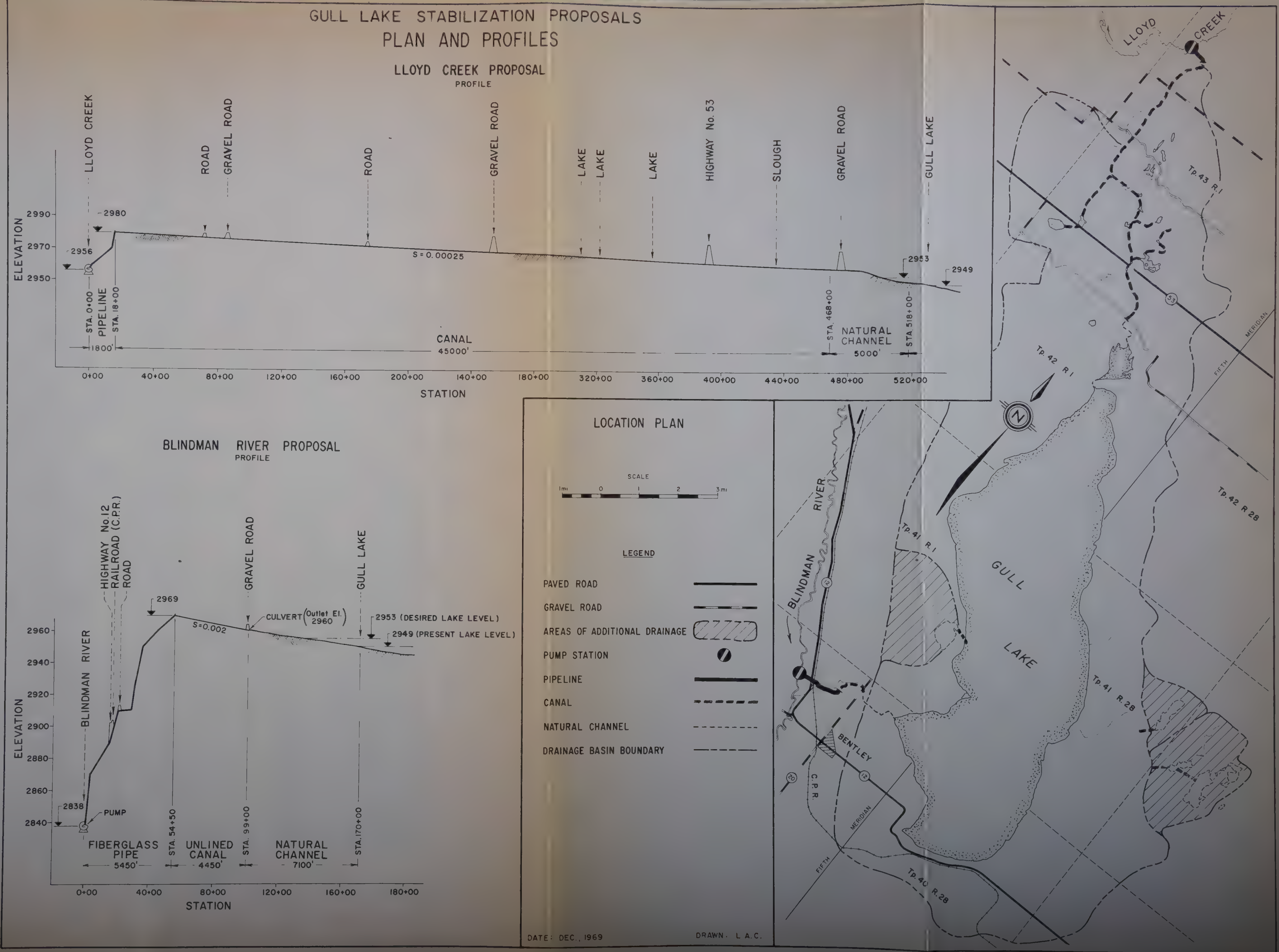
PREPARED E Podivinsky
T Sandhu

SUBMITTED T Mussivand

DRAWN L A C

CHECKED

GULL LAKE STABILIZATION PROPOSALS
PLAN AND PROFILES



LLOYD CREEK PROPOSAL
PROFILE

BLINDMAN RIVER PROPOSAL
PROFILE

LOCATION PLAN

LEGEND

PAVED ROAD	▬▬
GRAVEL ROAD	▬ ▬
AREAS OF ADDITIONAL DRAINAGE	▨
PUMP STATION	⊘
PIPELINE	▬▬
CANAL	‒ ‒ ‒ ‒
NATURAL CHANNEL	- - - - -
DRAINAGE BASIN BOUNDARY	— — —

DATE: DEC., 1969

DRAWN. L.A.C.

PLATE No. 4

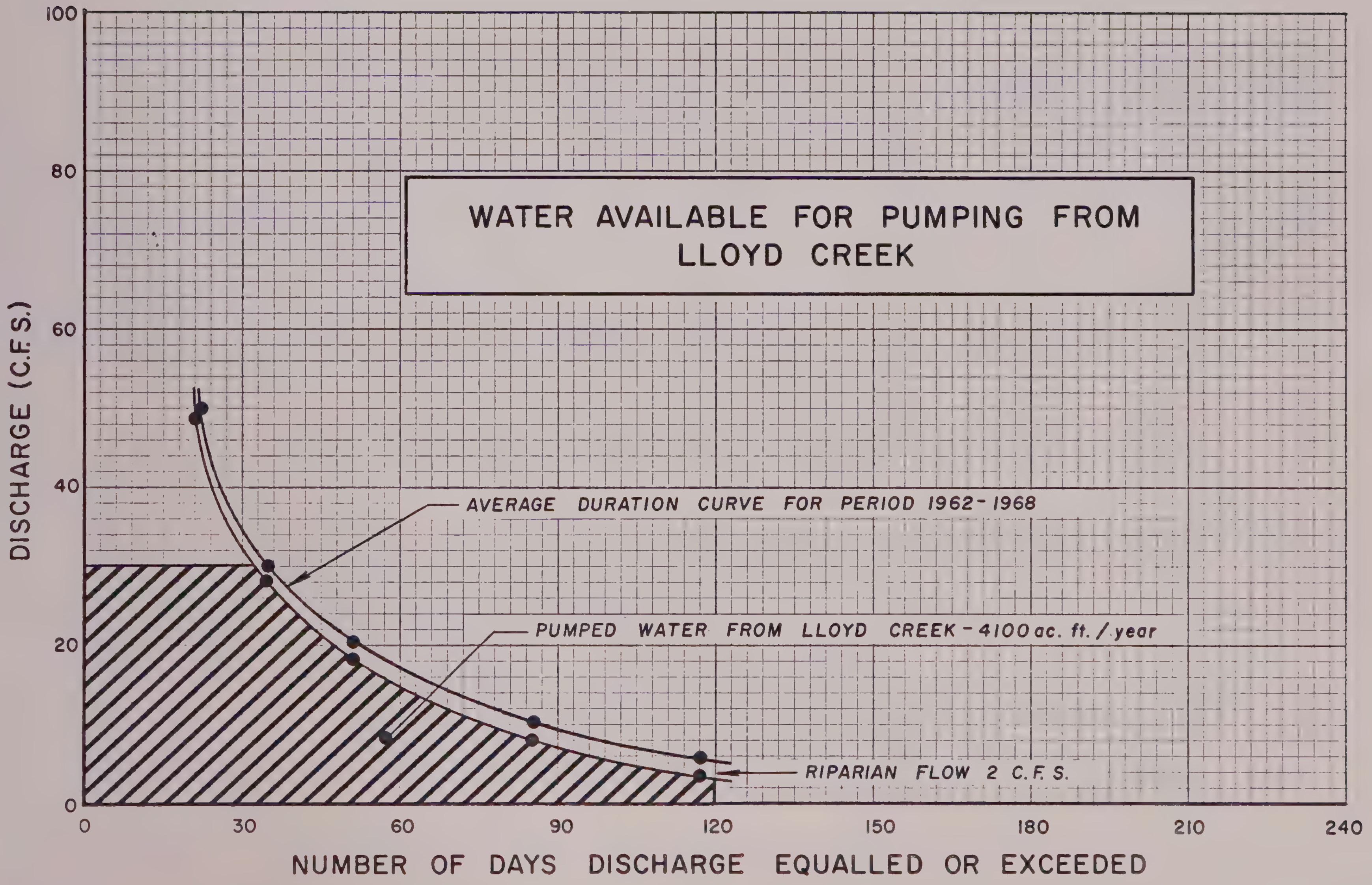

WATER AVAILABLE FOR PUMPING FROM LLOYD CREEK
AVERAGE DURATION CURVE FOR PERIOD 1962-1968
PUMPED WATER FROM LLOYD CREEK - 4100 ac. ft. / year
RIPARIAN FLOW 2 C.F.S.
DISCHARGE (C.F.S.)
100
80
60
40
20
0
0
30
60
90
120
150
180
210
240
NUMBER OF DAYS DISCHARGE EQUALLED OR EXCEEDED

PLATE No.5

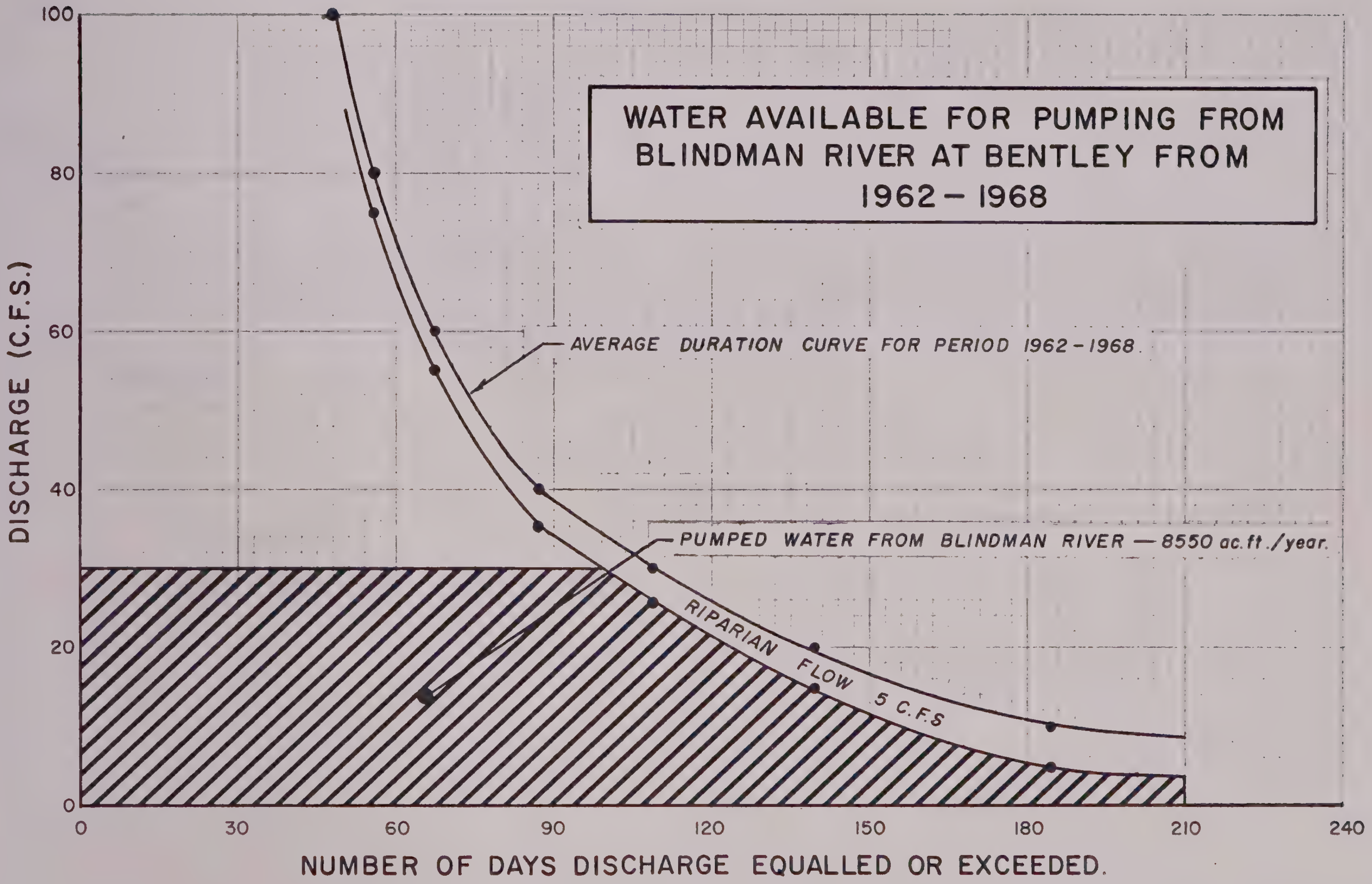
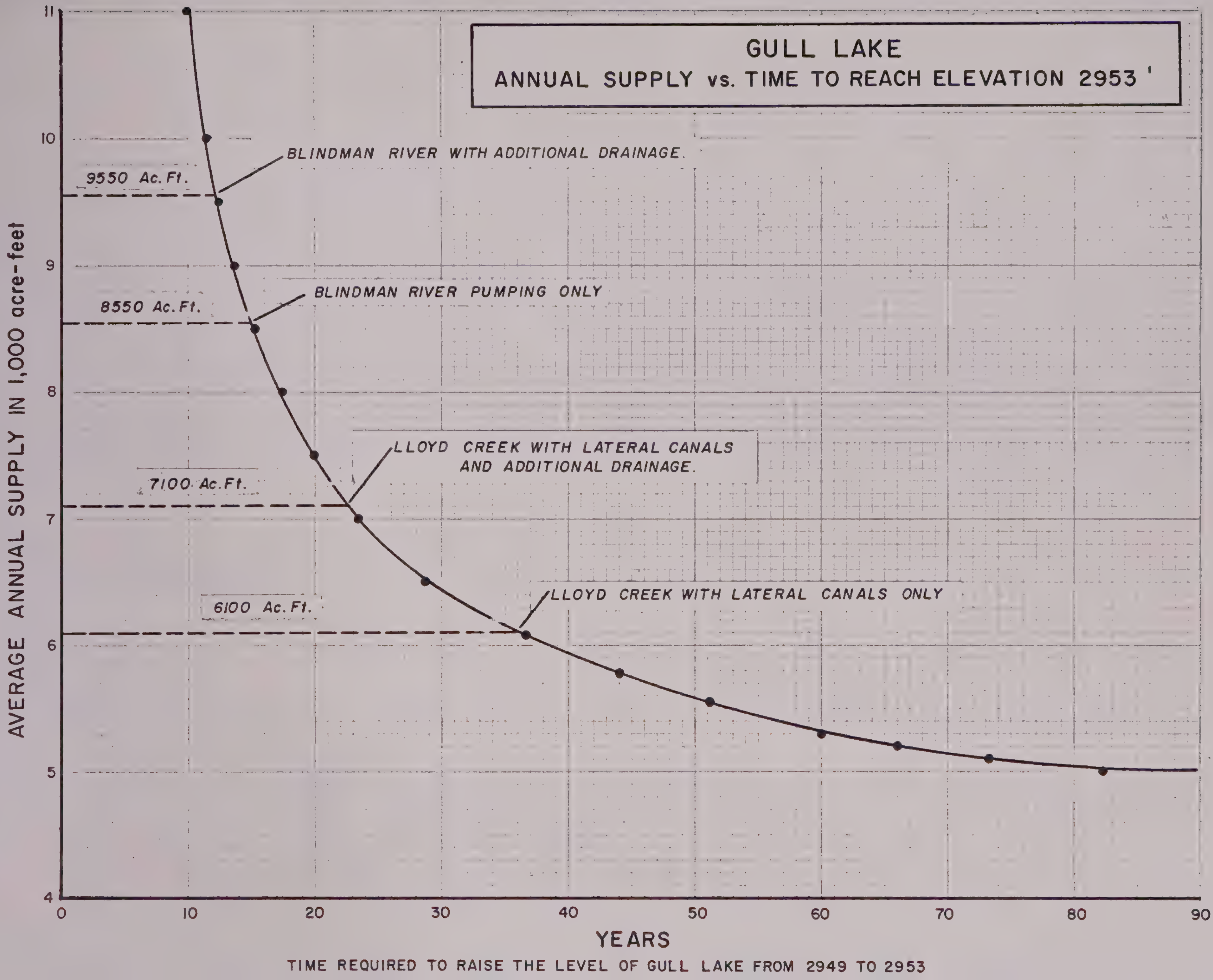

WATER AVAILABLE FOR PUMPING FROM BLINDMAN RIVER AT BENTLEY FROM 1962 – 1968
AVERAGE DURATION CURVE FOR PERIOD 1962 - 1968.
PUMPED WATER FROM BLINDMAN RIVER — 8550 ac. ft. / year.
RIPARIAN FLOW 5 C.F.S
DISCHARGE (C.F.S.)
100
80
60
40
20
0
0
30
60
90
120
150
180
210
240
NUMBER OF DAYS DISCHARGE EQUALLED OR EXCEEDED.

PLATE No. 6



GULL LAKE
ANNUAL SUPPLY vs. TIME TO REACH ELEVATION 2953 '

PLATE No. 7

GULL LAKE LEVELS

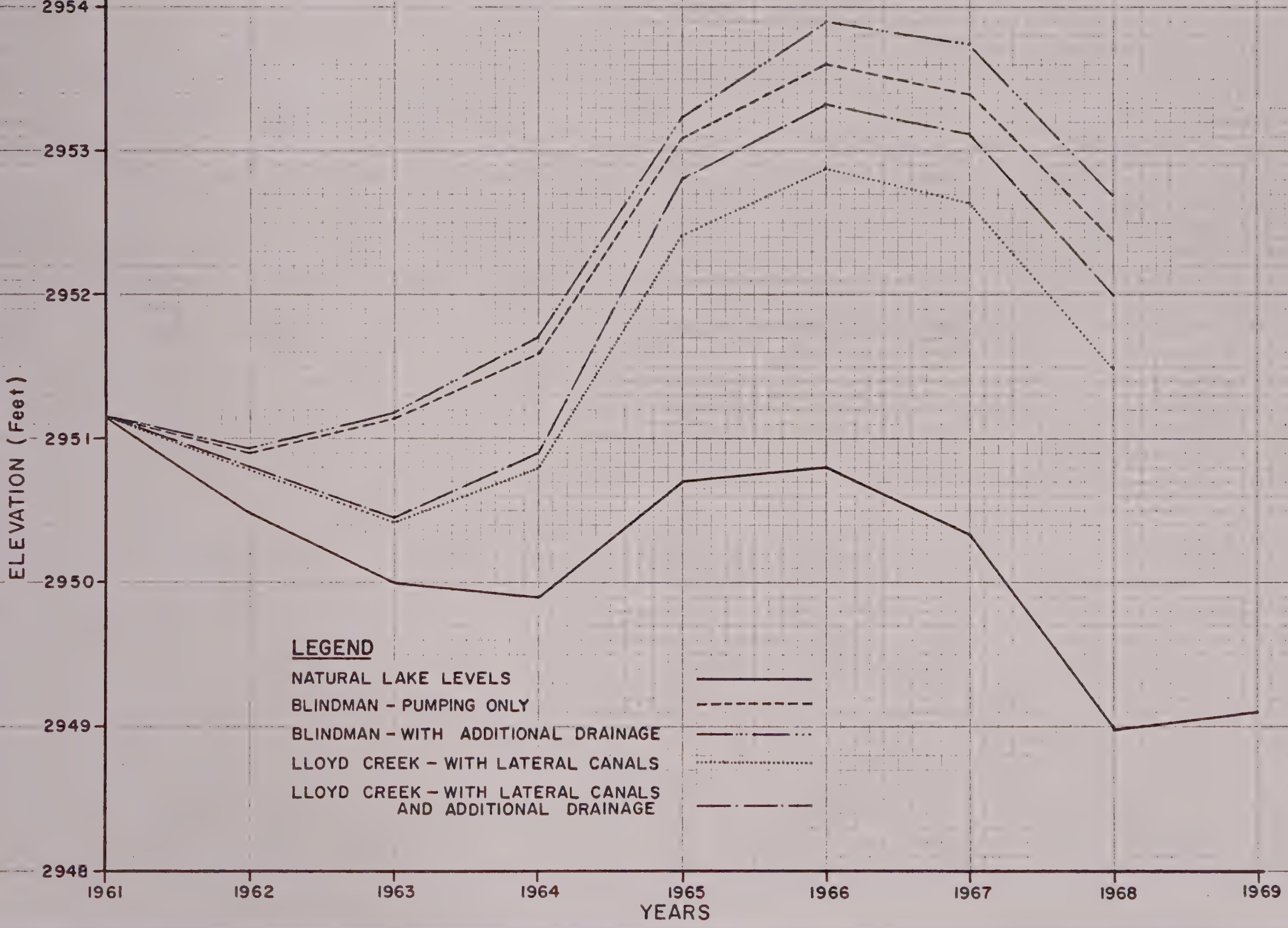


PLATE No. 8

COST ESTIMATES AND ANNUAL CHARGES
FOR
GULL LAKE STABILIZATION PROPOSALS.

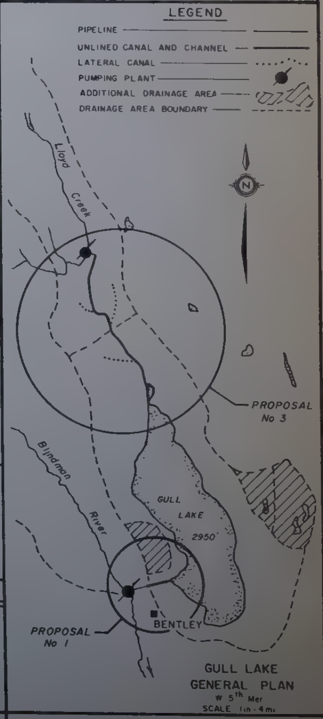
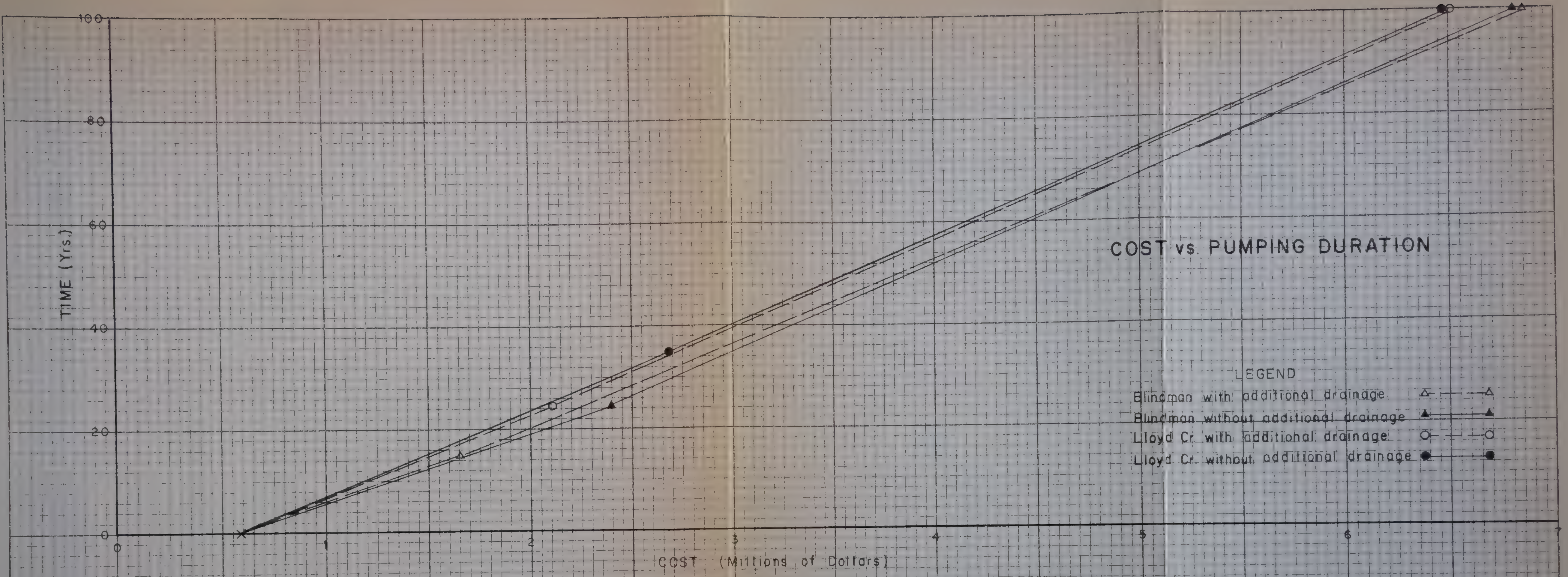
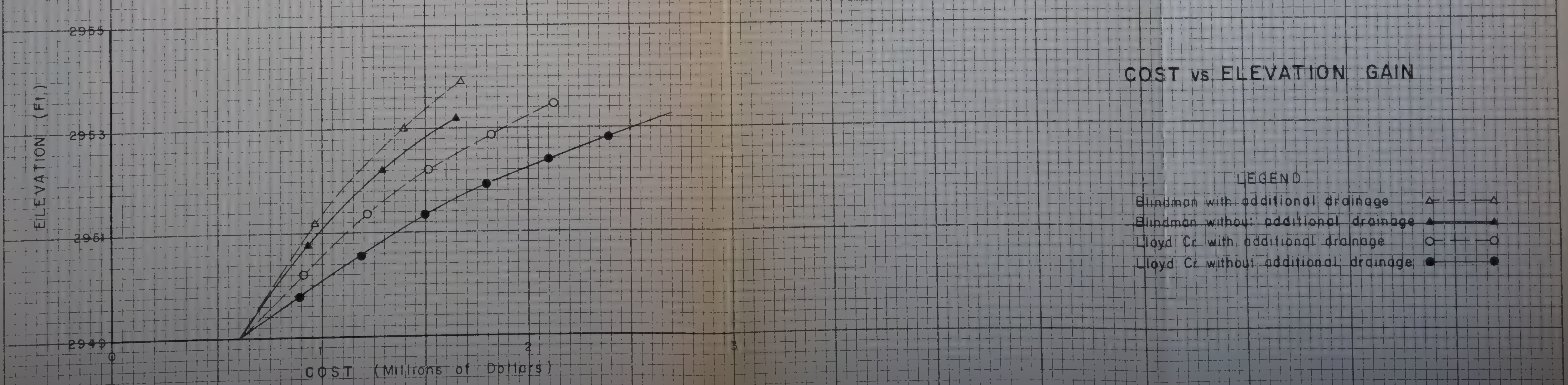
ITEM	UNIT	UNIT COST (IN DOLLARS)	1 BLINDMAN RIVER PUMPING ONLY.		2 BLINDMAN RIVER PLUS ADDED DRAINAGE.		3 LLOYD CREEK PUMPING AND LATERAL CANALS.		4 LLOYD CREEK PUMPING AND LATERAL CANALS PLUS ADDED DRAINAGE		SOURCE OF UNIT PRICE.
			QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	
PUMPING PLANT			1	215,000	1	215,000	1	150,000	1	150,000	TECHNICAL REPORT No. 2 , S.N.B.B.
CONTROL STRUCTURE.			1	20,000	1	20,000	1	13,000	1	13,000	LUMP SUM
FIBRE GLASS PRESSURE PIPE.	FT.	25.00	5450	136,000	5450	136,000	1,800	45,000	1,800	45,000	PRICE LIST.
CANAL EXCAVATION.	$YD.^3$	0.60	8900	5,300	8900	5,300					WATER RESOURCES, CONST. BRANCH.
CANAL EXCAVATION.	$YD.^3$	0.40					315,000	126,000	315,000	126,000	"
CANAL FILL.	$YD.^3$	0.15	8900	1,400	8900	1,400	258,000	38,700	258,000	38,700	"
RIP RAP.	$YD.^3$	15.00	50	750	50	750	50	750	50	750	"
SEEPAGE CONTROL BLANKET.	$YD.^3$	1.00	500	500	500	500					TECHNICAL REPORT No 2, S.N.B.B.
DROP STRUCTURES.	No.	3,000					3	9,000	3	9,000	WATER RESOURCES, CONST. BRANCH.
RAILWAY AND ROAD CROSSINGS.	No.	2,000	4	8,000	4	8,000	5	10,000	5	10,000	"
POWERLINE							1	1,500	1	1,500	CALGARY POWER, PANAR CONSULTING
ADDITIONAL DRAINAGE DITCHES.	FT.	1.00			7,000	7,000			7,000	7,000	WATER RESOURCES, CONST. BRANCH.
LAND ACQUISITION	ACRES.	100	6	600	14	1,400	77	7,700	85	8,500	WATER RESOURCES, LAND BUYER.
SUB TOTALS.				387,550		395,350		401,650		409,450	
CONTINGENCIES 20 %				77,500		79,000		80,330		81,890	
SUB TOTALS				465,050		474,350		481,980		491,340	
ENGINEERING, DESIGN, SURVEY.											
A. PUMPING 25%				64,500		64,500		45,500		45,500	
B. CONSTRUCTION 18 %				37,100		38,600		53,800		55,400	
FIRST COST.				566,650		577,450		581,280		592,240	
INTEREST (ONE YEAR CONSTRUCTION PERIOD AT 8%)				22,666		23,098		23,251		23,689	
TOTAL INVESTMENT				589,316		600,548		604,531		615,929	
ANNUAL CHARGES											
INTEREST. (8% OF TOTAL INVESTMENT)				47,145		48,044		48,362		49,274	
DEPRECIATION.											
A. EARTHWORKS (100 YEARS AT 8%)				1		1		6		7	
B. STRUCTURES (50 YEARS AT 8%).				345		345		162		162	
C. PUMPING PLANTS (25 YEARS AT 8%)				3,535		3,535		2,491		2,491	
				3,881		3,881		2,659		2,660	
OPERATION AND MAINTENANCE.											
A. CANAL. ——— MAIN.	MILE	500	1	500	1	500	8.5	4,250	8.5	4,250	
——— OTHER.	MILE	200			1.3	260	4	800	5.3	1,060	
B. POWER.				19,300		19,300		3,500		3,500	
TOTAL ANNUAL CHARGES.				70,826		71,985		59,571		60,744	
ANNUAL CHARGE AFTER RAISING WATER LEVEL.				60,986		59,885		57,946		58,264	
SUMMARY:											
TOTAL INVESTMENT.				589,316		600,548		604,531		615,929	
ANNUAL CHARGES				70,826		71,985		59,571		60,744	
ANNUAL CHARGES (AFTER RAISING WATER LEVEL)				60,986		59,885		57,946		58,264	

PLATE No. 9

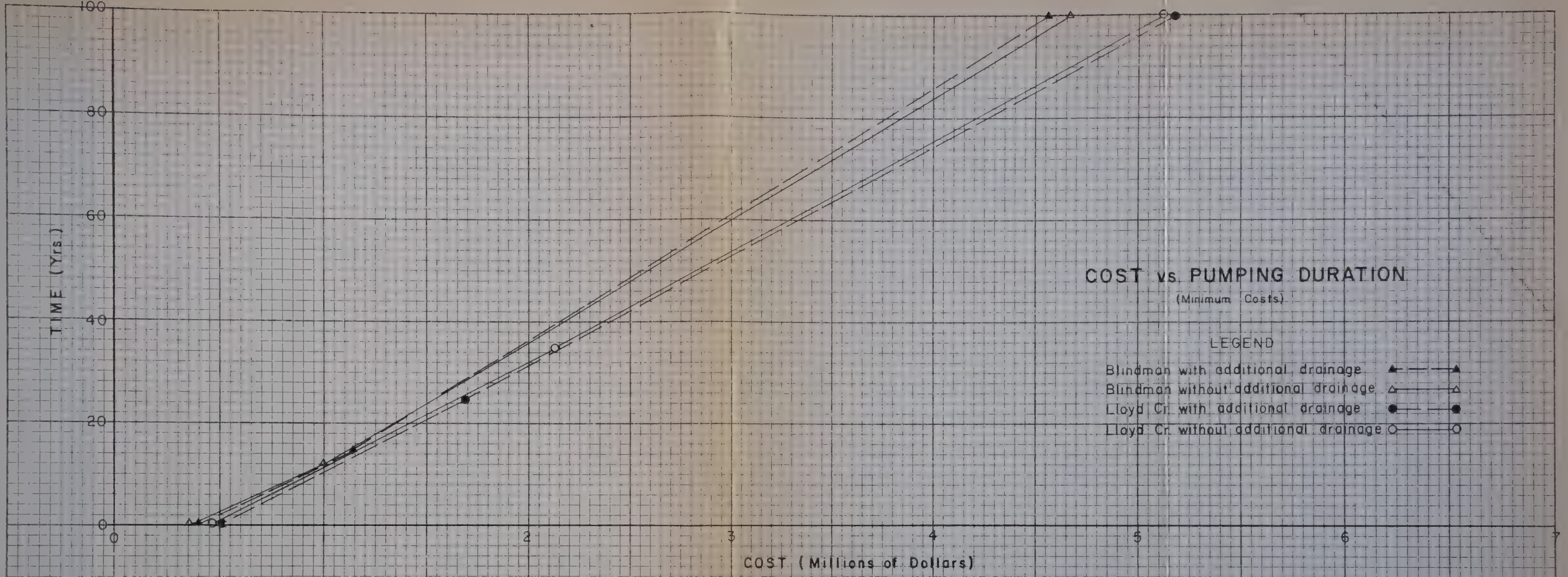


COST vs. PUMPING DURATION



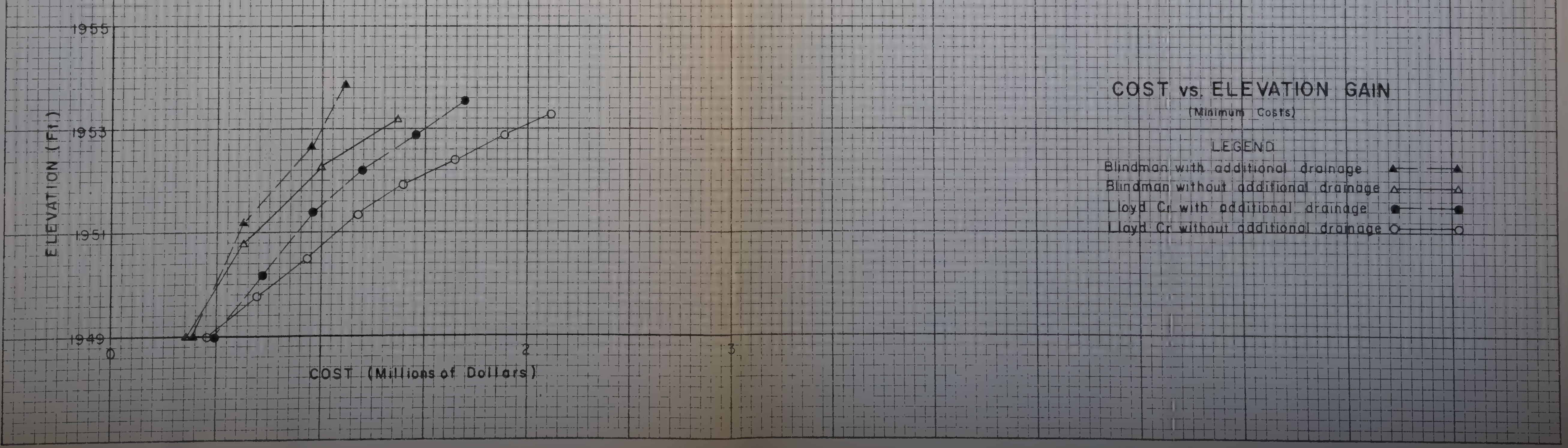
COST vs. ELEVATION GAIN

PLATE No 10



COST vs. PUMPING DURATION

(Minimum Costs)



COST vs. ELEVATION GAIN

(Minimum Costs)

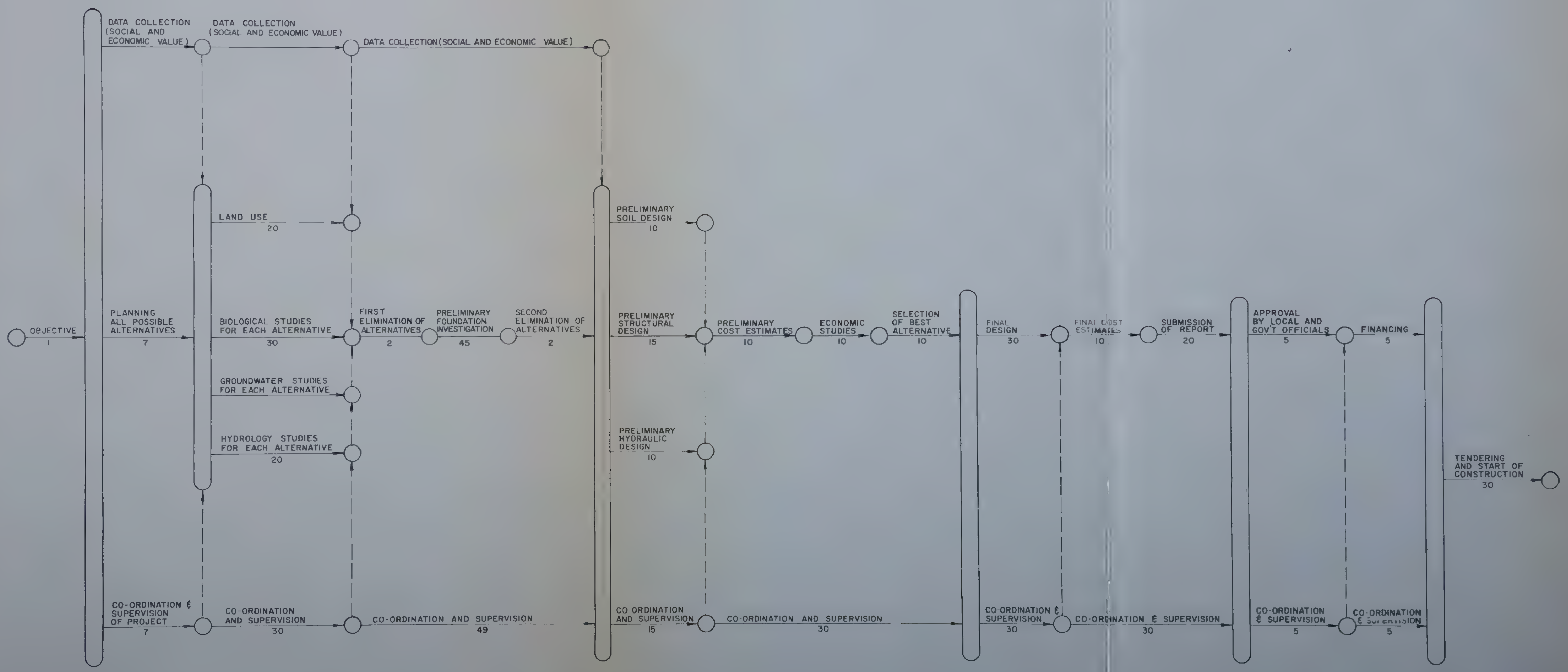
PLATE No 10a

K+E 10 X 10 TO THE INCH 47 0706
10 X 15 IN. • ALBANENE®
KEUFFEL & ESSER CO. MADE IN U.S.A.

FIRST STAGE

GULL LAKE STUDIES

NETWORK DIAGRAM


OBJECTIVE 1
DATA COLLECTION (SOCIAL AND ECONOMIC VALUE)
DATA COLLECTION (SOCIAL AND ECONOMIC VALUE)
DATA COLLECTION (SOCIAL AND ECONOMIC VALUE)
PLANNING ALL POSSIBLE ALTERNATIVES 7
CO-ORDINATION & SUPERVISION OF PROJECT 7
LAND USE 20
BIOLOGICAL STUDIES FOR EACH ALTERNATIVE 30
GROUNDWATER STUDIES FOR EACH ALTERNATIVE
HYDROLOGY STUDIES FOR EACH ALTERNATIVE 20
CO-ORDINATION AND SUPERVISION 30
FIRST ELIMINATION OF ALTERNATIVES 2
PRELIMINARY FOUNDATION INVESTIGATION 45
SECOND ELIMINATION OF ALTERNATIVES 2
CO-ORDINATION AND SUPERVISION 49
PRELIMINARY SOIL DESIGN 10
PRELIMINARY STRUCTURAL DESIGN 15
PRELIMINARY HYDRAULIC DESIGN 10
CO ORDINATION AND SUPERVISION 15
PRELIMINARY COST ESTIMATES 10
ECONOMIC STUDIES 10
SELECTION OF BEST ALTERNATIVE 10
CO-ORDINATION AND SUPERVISION 30
FINAL DESIGN 30
CO-ORDINATION & SUPERVISION 30
FINAL COST ESTIMATES 10
SUBMISSION OF REPORT 20
CO-ORDINATION & SUPERVISION 30
APPROVAL BY LOCAL AND GOV'T OFFICIALS 5
CO-ORDINATION & SUPERVISION 5
FINANCING 5
CO-ORDINATION & SUPERVISION 5
TENDERING AND START OF CONSTRUCTION 30

NOTES:

1. TIMES ARE IN MAN/DAYS
2. HOLIDAYS ARE NOT INCLUDED

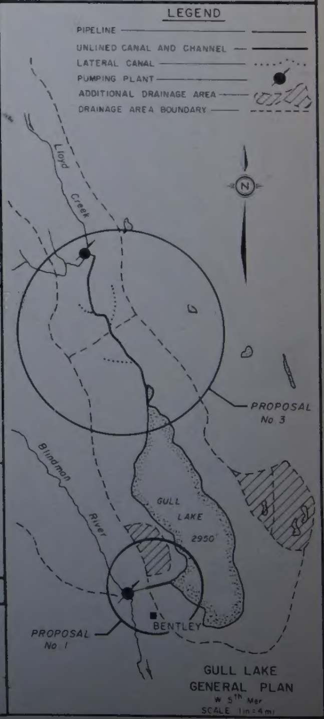
PREPARED BY
T.V MUSSIVAND
ALBERTA WATER RESOURCES DIVISION
DEVELOPMENT PLANNING BRANCH
MARCH, 1969

PLATE No. 11

COST ESTIMATES AND ANNUAL CHARGES
FOR
GULL LAKE STABILIZATION PROPOSALS.

MAINTAINING THE PRESENT LAKE LEVEL (2949').

ITEM	UNIT	UNIT COST (IN DOLLARS)	1 BLINDMAN RIVER PUMPING ONLY.		2 BLINDMAN RIVER PLUS ADDED DRAINAGE.		3 LLOYD CREEK PUMPING AND LATERAL CANALS		4 LLOYD CREEK PUMPING AND LATERAL CANALS PLUS ADDED DRAINAGE.		SOURCE OF UNIT PRICE.
			QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	
PUMPING PLANT.			1	105,000	1	90,000	1	90,000	1	65,000	TECHNICAL REPORT No. 2, S.N.B.B.
CONTROL STRUCTURE.			1	20,000	1	20,000	1	13,000	1	13,000	LUMP SUM.
FIBRE GLASS PRESSURE PIPE.	FT.	AS SHOWN	5450 21"Ø@ 17.75/L.ft.	96,700	5450 19"Ø@ 16.25/L.ft	88,600	1800 24"Ø@ 20.00/L.ft.	36,000	1800 18"Ø@ 15.50/L.ft.	27,900	PRICE LIST.
CANAL EXCAVATION.	YD.^{3}	0.60	8900	5,300	8900	5,300					WATER RESOURCES, CONST. BRANCH.
CANAL EXCAVATION.	YD.^{3}	0.40					315,000	126,000	315,000	126,000	"
CANAL FILL.	YD.^{3}	0.15	8900	1,400	8900	1,400	258,000	38,700	258,000	38,700	"
RIP RAP.	YD.^{3}	15.00	50	750	50	750	50	750	50	750	"
SEEPAGE CONTROL BLANKET.	YD.^{3}	1.00	500	500	500	500					TECHNICAL REPORT No. 2, S.N.B.B.
DROP STRUCTURES.	No.	3,000					3	9,000	3	9,000	WATER RESOURCES, CONST. BRANCH.
RAILWAY AND ROAD CROSSINGS.	No.	2,000	4	8,000	4	8,000	5	10,000	5	10,000	"
POWERLINE							1	1,500	1	1,500	CALGARY POWER.
ADDITIONAL DRAINAGE DITCHES.	FT.	1.00			7000	7,000			7000	7,000	WATER RESOURCES, CONST. BRANCH.
LAND ACQUISITION	ACRES.	100	6	600	14	1,400	77	7,700	85	8,500	WATER RESOURCES, LAND BUYER.
SUB TOTALS.				238,250		222,950		332,650		307,350	
CONTINGENCIES 20 %				47,650		44,590		66,530		61,470	
SUB TOTALS.				285,900		267,540		399,180		368,820	
ENGINEERING, DESIGN, SURVEY.											
A. PUMPING 25%				31,500		27,000		27,000		19,500	
B. CONSTRUCTION 18%				28,652		28,415		50,749		50,512	
FIRST COST.				346,052		322,955		476,929		438,832	
INTEREST DURING FIRST YEAR OF CONSTRUCTION. (8%)				13,842		12,918		19,077		17,553	
TOTAL INVESTMENT				359,894		335,873		496,006		456,385	
ANNUAL CHARGES											
INTEREST. (8% OF TOTAL INVESTMENT.)				28,792		26,870		39,680		36,511	
DEPRECIATION.											
A. EARTHWORKS (100 YEARS AT 8 %)				1		1		6		7	
B. STRUCTURES (50 YEARS AT 8%).				262		245		146		129	
C. PUMPING PLANTS (25 YEARS AT 8%)				1,726		1,480		1,480		1,069	
				1,989		1,726		1,632		1,205	
OPERATION AND MAINTENANCE.											
A. CANAL. — MAIN.	MILE	500	1	500	1	500	8.5	4,250	8.5	4,250	
— OTHER.	MILE	200			1.3	260	4	800	5.3	1,060	
B. POWER.				11,900		9,550		2,660		1,930	
TOTAL ANNUAL CHARGES.				43,181		38,906		49,022		44,956	
SUMMARY.											
TOTAL INVESTMENT.				359,894		335,873		496,006		456,385	
ANNUAL CHARGES.				43,181		38,906		49,022		44,956	



GULL LAKE
GENERAL PLAN
W 5th Mer
SCALE 1in = 4mi

PLATE No. 12